

1. A method of printing on substrate comprising the steps of:
  - moving a print head carriage, having at least one ink jet nozzle thereon, parallel to a plane in which is supported a substrate having a surface that is at a nonuniform location relative to said plane;
  - 5        adjusting the distance from the nozzle to the plane to position the nozzle at a predetermined distance from the surface of the substrate where ink is to be jetted from the nozzle;
  - jetting ink from the nozzle across the predetermined distance onto the surface of a substrate.
- 10       2. The method of claim 1 wherein:
  - the ink is UV curable ink;
  - the method further comprises the step of at least partially curing the ink jetted onto the surface by exposing the jetted ink to ultraviolet light.
- 15       3. The method of claim 1 further comprising the steps of:
  - sensing the position of the surface of the substrate relative to the carriage;
  - and
  - the adjusting of the distance from the nozzle to the plane is performed in response to said sensing.
- 20       4. The method of claim 1 wherein:
  - the sensing of the positions is carried out while moving the print head carriage; and
  - the adjusting includes varying the position of the nozzle relative to the plane as the print head carriage moves so as to maintain the predetermined distance across the substrate in response to the sensed distance.

5. A method of printing on rigid panels comprising the steps of:  
moving parallel to a rigid panel a print head carriage having an ink jet nozzle thereon directed toward a surface of the panel;  
automatically adjusting the distance of the nozzle from the panel to  
5 maintain a predetermined distance between the nozzle and the surface of the panel at the location onto which ink is to be jetted from the nozzle; and  
while moving the print head carriage, jetting ink from the nozzle across the predetermined distance and onto the surface of the rigid panel.
6. The method of claim 5 wherein:  
10 the surface of the panel onto which the ink is jetted varies across the panel in its distance from the carriage; and  
the adjusting includes varying the position of the nozzle relative to the panel as the print head is moved to maintain the predetermined spacing between the nozzle and the location on the surface at which the ink is jetted.
- 15 7. The method of claim 6 further comprising the step of:  
sensing the distance between the print head carriage and locations on the surface at which ink is to be jetted; and  
varying the position of the nozzle relative to the print head carriage in response to the sensed distance.
- 20 8. The method of claim 6 further comprising the step of:  
sensing the contour of the surface of the panel; and  
moving the carriage parallel to the panel to locations determined in response to the sensed contour and jetting the ink onto the surface of the panel at said locations.
- 25 9. The method of claim 5 wherein:  
the ink is UV curable ink;  
the method further comprises the step of at least partially curing the ink jetted onto the surface by exposing the jetted ink to ultraviolet light.

**10.** An apparatus for printing on a surface of a three-dimensional substrate comprising:

a frame having a substrate support mounted thereon defining a substrate supporting plane and a print head track extending parallel to the plane;

5       at least one ink jet print head having at least one nozzle thereon and moveably supported on the track with the nozzle directed toward the surface of a substrate supported by the substrate support;

a sensor operable to determine a distance therefrom of a portion of the surface; and

10       the nozzle being moveable perpendicular to the plane in response to the sensor to a predetermined distance from the surface of the substrate; and

a controller operable to move and control the nozzle to print on the substrate by jetting ink from the nozzle across the predetermined distance and onto the surface of a substrate.

15       **11.** The apparatus of claim **10** further comprising:

a UV light curing head on the frame and positioned so as to expose ink jetted onto the surface of a substrate by the print head to UV light;

the UV light curing head is moveable perpendicular to the plane; and

20       the controller is operable to move the curing head to maintain focus of UV light from the print head on ink jetted onto the surface of the substrate.

**12.** The apparatus of claim **10** wherein:

the sensor is a non-contact, distance measuring device that includes a light source and light detector mounted on the track.

**13.** The apparatus of claim **10** wherein:

25       the sensor is a non-contact, distance measuring device that includes a light source and light detector mounted on the track; and

the track has further mounted thereon a servo motor responsive to an output signal from the sensor to adjust the position of the nozzle.

**14.** The apparatus of claim **10** wherein:

the sensor includes moveable mechanical elements that maintain contact with the surface of the substrate; and

the nozzle is linked to the mechanical elements so as to move in response thereto.

**15.** A system for printing images on a substrate, comprising:  
a multiplicity of print heads mounted in a carriage, the print heads being  
positioned a distance from the substrate;

a sensor which detects the thickness of the substrate; and

5 a control system which receives the substrate thickness information  
detected by the sensor and transmits signals to a motor coupled to the carriage,  
the transmitted signals instructing the motor to adjust the position of the carriage  
to maintain a desired gap between the print heads and the substrate.

**16.** The system of claim **15**, wherein the control system includes a  
10 controller which transmits the signals to the motor.

**17.** The system of claim **16**, wherein the controller is coupled to a CPU  
which receives a substrate thickness information signal from the sensor,  
processes the information, and transmits signals to the controller to instruct the  
motor to adjust the position of the carriage to maintain the desired gap.

15 **18.** The system of claim of claim **16**, wherein the control system includes  
a feedback device which senses the gap between the print heads and the  
substrate, the gap information being relayed to the controller such that the  
controller can further instruct the motor to alter the position of the print heads  
relative to the substrate to achieve the desired gap.

**19.** The system of claim **18**, wherein the feedback device transmits the gap information to a CPU which process the information and relays the processed gap information to the controller.

**20.** The system of claim **15**, wherein the motor is a servo motor.

5      **21.** The system of claim **15**, wherein the minimum gap is about 0.04 inch.

**22.** The system of claim **20**, wherein the maximum gap is about 0.08 inch.

**23.** The system of claim **15**, wherein upon the sensor detecting the thickness of the substrate, the position of the carriage is adjusted in less than about five seconds.

10      **24.** The system of claim **15**, wherein the sensor includes an indicator roller.

**25.** The system of claim **24**, wherein the sensor includes a dial indicator coupled to the indicator roller.

15      **26.** The system of any of claims **15** through **25** further comprising a table adapted to support the substrate, including flexible and non-flexible substrates.

**27.** The system of claim **26**, wherein the sensor detects the thickness of the substrate as the substrate moves through the system.

**28.** The system of any of claims **15** through **25** wherein the sensor detects the thickness of the substrate as the substrate moves through the system.

20      **29.** The system of claim **15**, wherein the difference between the minimum gap and maximum gap is at least about one millimeter (0.04 inch).

**30.** The system of claim **29** further comprising:

a table adapted to support the substrate, including flexible and non-flexible substrates.

**31.** The system of claim **15**, wherein the sensor is mounted in the  
5 carriage.

**32.** The system of claim **15**, wherein the sensor includes two sensors mounted in the carriage.

**33.** The system of claim **15**, wherein:

the print heads are bidirectional print heads that print while moving  
10 transversely across a substrate that is moveable longitudinally relative to the print heads,

the sensor includes two sensors mounted in the carriage transversely of the print heads, one on each side of the print heads.

**34.** A method for controlling the distance between print heads of a printing system and a substrate, comprising:

moving the substrate relative to the print heads;

5 detecting the thickness of the substrate while the substrate moves relative to the print heads;

transmitting the thickness information to a controller;

transmitting height adjustment information signals from the controller to a motor coupled to a carriage which holds the print heads; and

10 adjusting the position of the carriage with the motor to maintain a desired gap between the print heads and the substrate.

**35.** The method of claim **34**, further comprising detecting the distance between the print heads and the substrate.

**36.** The method of claim **35**, further comprising transmitting the distance information to the controller and re-adjusting the position of the print heads  
15 based on the distance information detected.

**37.** The method of claim **34**, wherein adjusting maintains the desired gap in the range from about 0.04 inch to about 0.08 inch.



**38.** The method of any of claims **34** through **37** further comprising:  
positioning a substrate on a table adapted to support flexible and non-  
flexible substrates.

**39.** The method of claim **34**, wherein adjusting maintains the desired gap  
5 over a range of at least about one millimeter (0.04 inch).

**40.** The method of claim **39** further comprising:  
positioning a substrate on a table adapted to support flexible and non-  
flexible substrates.

**41.** The method of claim **34**, wherein:  
10 the moving of the substrate includes moving the substrate longitudinally  
relative to the printheads;  
the method further comprises moving the print heads transversely on a  
carriage relative to the substrate; and  
the transmitting of the thickness information includes transmitting the  
15 information from a sensor on the carriage.

**42.** The method of claim **41** wherein:  
the transmitting of the thickness information includes transmitting the  
information from at least one of at least two sensors mounted on the carriage.

**43.** A method of printing on a plurality of substrates, including flexible and non-flexible substrates, comprising:

positioning a first substrate having a first thickness on a table, the first substrate comprising a first one of a flexible and non-flexible substrate;

5 moving the first substrate relative to the print heads;

detecting the thickness of the first substrate;

transmitting the thickness information to a controller;

transmitting height adjustment information signals from the controller to a motor coupled to a carriage which holds the print heads;

10 adjusting the position of the carriage with the motor to maintain a desired gap between the print heads and the substrate;

printing an image on the first substrate;

positioning a second substrate having a second thickness on the table, the second substrate comprising the second one of a flexible and non-flexible substrate;

15

moving the second substrate relative to the print heads;

detecting the thickness of the second substrate;

transmitting the thickness information to a controller;

20 transmitting height adjustment information signals from the controller to a motor coupled to a carriage which holds the print heads;

adjusting the position of the carriage with the motor to maintain a desired gap between the print heads and the second substrate, the gap substantially identical to the gap between the print heads and the first substrate; and

printing an image on the second substrate.

**44.** The method of claim **43**, wherein the steps of detecting the thicknesses of the substrates, transmitting height adjustment signals, and adjusting the position of the carriage are performed automatically with substantially no user intervention.

5       **45.** The method of claim **43**, wherein the steps of detecting the thicknesses of the substrates, transmitting height adjustment signals, and adjusting the position of the carriage are all performed within about 5 seconds or less.

10       **46.** The method of any of claims **43** through **45** wherein the plurality of substrates includes flexible and non-flexible substrates, and wherein the positioning of the first substrate comprises a first one of a flexible and non-flexible substrate and the positioning of the second substrate comprises the second one of a flexible and non-flexible substrate.

15       **47.** The method of claim **43**, wherein:  
the transmitting of the thickness information includes transmitting the information from at least one sensor mounted on the carriage.

20       **48.** The method of claim **47**, wherein:  
the moving of a substrate includes moving the substrate longitudinally relative to the print heads and moving the print heads transversely on a carriage relative to a substrate.

**49.** The method of claim **48** wherein:  
the transmitting of the thickness information includes transmitting the information from at least one of at least two sensors mounted on the carriage.